VIRGINIA AGRICULTURAL COUNCIL PREPROPOSAL FORM

Title:

THE WILD BEES OF VIRGINIA

Include a brief explanation of the Economic impact the project would have on Virginia agriculture.

By supporting the biodiversity of native pollinator species, our agricultural community can secure "pollination insurance" that will moderate our dependency on the honey bee (*Apis mellifera*) as an exclusive source of pollination. The honey bee provides a yearly ~$110 million to Virginia's agricultural industry and yet is declining due to disease, parasites, and colony collapse disorder.

INVESTIGATOR(S)*_____Paul Marek (Entomology – Virginia Tech)_____
DURATION (years) one____two__X__
BUDGET (yr. one) _____15,000____(total)_____30,000_____
***<u>One</u> pre-proposal per PI please**

VIRGINIA AGRICULTURAL COUNCIL PREPROPOSAL FORM

COMMODITY GROUPS	**CHECK *ONE* GROUP THAT BEST DESCRIBES YOUR PROJECT**
Aquaculture	
Fruit/Wine	X
Livestock Dairy Poultry Hogs Beef Sheep Goats Horses	
Nursery/ Forestry	
Row Crops	
Turf/Seed	
Vegetable	
Educational	
Miscellaneous Agriculture	

THE WILD BEES OF VIRGINIA

The goal of this project is to document native pollinator species diversity and distribution in an effort to improve the pollination services of Virginia's crops. By supporting the biodiversity of native pollinator species, our agricultural community can secure "pollination insurance" that will moderate our dependency on the honey bee (*Apis mellifera*) as an exclusive source of pollination. Through detailed surveys of insect pollinators and digitization of specimens held in the Virginia Tech Insect Collection, we propose to establish a baseline dataset of pollinator species distributions across Virginia's agricultural lands. This project will provide a critical benchmark of insect pollinators of fruit and vegetable crops to determine the efficacy of native species as pollinators. This project is an exciting foundational step toward understanding native pollination services and developing specific measures to enhance their benefit for agriculture in the state. Our project will implement an east-west transect across the entire state by sampling native bees in agricultural plots in each of the seven ecoregions in Virginia. We will incorporate a visible educational component with students at Virginia Tech, and provide outreach to elementary school students by introducing native leaf-cutter bee habitats.

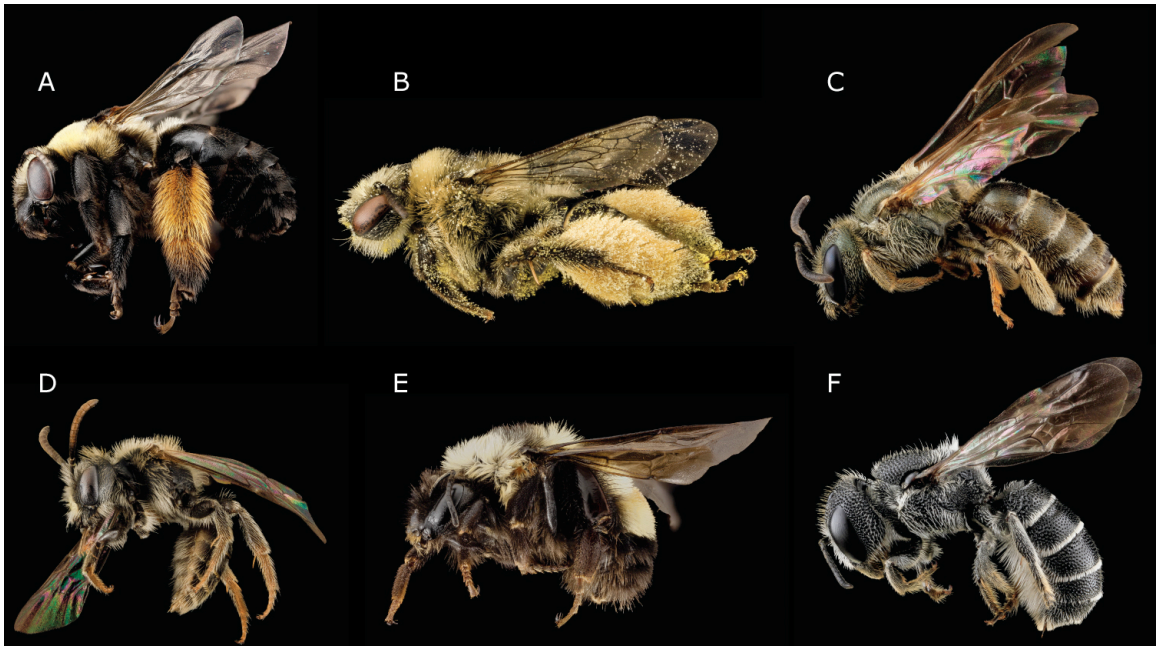

Fig. 1. A modest sampling of Virginia's native bees: A. *Melissodes desponsa*; B. *Melissodes druriella*; C. *Halictus confusus*; D. *Andrena ziziaformis*; E. *Bombus affinis*; F. *Heriades carinatus*. (Images by S. Droege, USGS Native Bee Inventory)

According to 2005 agricultural data, the total economic value of pollination services exceeds $200 billion per year for the top 100 crops used globally for human food sources (Gallai et al., 2009; Losey and Vaughan, 2006). While the importance of the honey bee is well documented—this single species supports 90 commercially grown crops in the U.S. and provided $110 million to Virginia's agricultural industry in 2007—the benefit of native pollinators is undocumented.

The consequences of losing pollinators are dire. Declining numbers of the honey bee due to Colony Collapse Disorder have caused destabilization of many agricultural systems. Continued loss of this species will be catastrophic, especially for food plants that rely exclusively on honey bees for pollination. Many other crops obtain up to 90% of their pollination from this species. The outcome of native pollinator loss is not well understood due to the absence of baseline data on pollinator species diversity and distribution.

Some species of native bumble bees are demonstrably more effective pollinators of certain crops than domesticated honey bees, *e.g.*, species relying on buzz pollination, greenhouse tomatoes, and many nursery plants (Kendall and Smith, 1975). Furthermore, in some crop systems that support both native bees and honey bees, seed set of flowers increased five-fold compared to fields with honey bees alone (Greenleaf and Kremen, 2006). Unfortunately, very little is known about flies, beetles, butterflies, and other pollinators.

This research proposes to document insect pollinator species diversity and distribution in Virginia through (1) surveys of native bees in the state's seven level-three ecoregions and (2) digitization of pollinator insects conserved in the Virginia Tech Insect Collection.

OBJECTIVE 1: INSECT POLLINATOR SURVEYS

Little is known about the role of non-honey bee pollinators in crop systems in the eastern U.S.; however, there are some native species widely recognized as effective pollinators, including bumble, squash and mason bees. In a research article published in 2012, Adamson et al. demonstrated that wild bees comprised 63% of the bees visiting caneberries and 83% visiting cucurbits. Surprisingly, and just among cucurbits (which harbored the greatest diversity and abundance of native bees), there was only a 13% similarity of species assemblages between farms. This study, conducted in caneberry, cucurbit, apple, and blueberry farms in just seven of the 95 counties in Virginia, provides an exciting glimpse of the full scope of native pollinator diversity of our state.

In this objective, we propose to sample bees in each of the state's seven level-three ecoregions, representing natural boundaries characterized by differing soil, land use, topography, and natural vegetation features (Fig. 2). We will collect both wild bees and honey bees from apple, blueberry, caneberry, and cucurbit flowers in each of the seven regions. Surveys will follow techniques successfully implemented by Adamson et al. (2012) and the USGS Bee Monitoring Laboratory (Droege, 2012). Briefly, crop flowers will be examined along a 40-m transect every 45 s (Adamson et al. 2012; Winfree et al. 2008). Bees will be collected with an aerial insect net and placed in a jar with cyanide. Bee DNA will be preserved in the Virginia Tech Insect Collection frozen tissue archive. To supplement hand collecting, bowl traps will be used. Colorful plastic bowls with soap will be placed in fields to capture specimens. Bees are attracted to the bright colors, slip on the soap, and drown in the water (Droege, 2012). These techniques will be standardized at all sites. Data will be analyzed to examine differences and similarities of bee species composition and abundance between sites and crops.

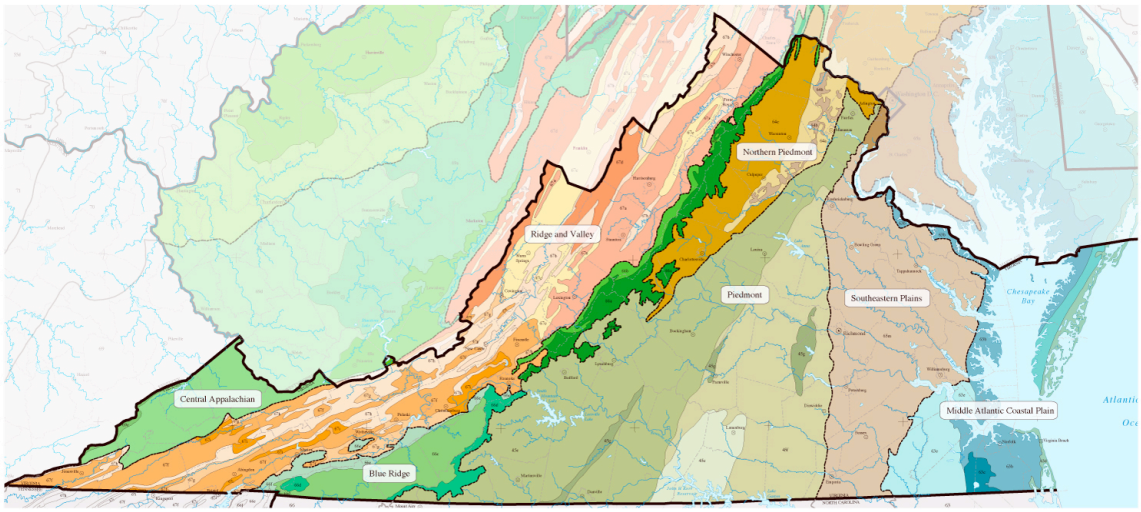

Fig. 2. Map of Virginia's seven ecoregions: Blue Ridge, Central Appalachian, Ridge and Valley, Piedmont, North Piedmont, Southern Plains, and Middle Atlantic Coastal Plain.

OBJECTIVE 2: DIGITIZATION OF NATIVE BEE SPECIMENS

We will digitize and database the native bee specimens in the Virginia Tech Insect Collection (VPIC). Operating since the late 19th century, the VPIC is the oldest and largest collection of insects in the state. Of the nearly half-million specimens, 80% are identified to species, and yet none of these have been catalogued. As a result, these specimens and their value as a reference of the state's native pollinator fauna remain "dark data", untapped as a scientific resource. Our digitization project will complement the survey in objective 1 and provide a historical baseline for assessment and prediction. With this dataset, we will establish a foundation to understand demographic changes of native pollinators and to track the extent of population contraction and expansion.

We adopted iDigBio's best practices for digitizing material and designed a digitization system for capturing high-resolution images of specimens and their associated label data (iDigBio, 2013). Digitization consists of three steps: (1) staging to photograph the specimen and its labels, (2) transcription of label data and inclusion into the database, and (3) georeferencing locality details to determine geographical coordinates and elevation. Harvard's Museum of Comparative Zoology successfully implemented a similar system for digitizing its butterfly collection (Nelson et al., 2012). Digitization and photography will use P. Marek's macrophotography system centered on a Canon 6D dSLR and a 50 mm macro lens (collection.ento.vt.edu).

This project provides baseline pollinator data that can be used to identify strategies to enhance pollination services for agriculture. Data will be made freely available online and provide a foundation to improve competitiveness for anticipated funding opportunities related to a recent White House memorandum aimed at protecting and restoring domestic populations of pollinators.